ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C.

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In the Matter of	)	
	)	
Amendment of Parts 2 and 25 of the	)	ET Docket No. 98-206
Commission's Rules to Permit Operation of	)	RM-9147
NGSO and FSS Systems Co-Frequency	)	RM-9245
With GSO and Terrestrial Systems in the	)	
Ku-Band Frequency Range	)	
	)	
and	)	
	)	
Amendment of the Commission's Rules to	)	
Authorize Subsidiary Terrestrial Use of the	)	
12.2-12.7 GHz Band by Direct Broadcast	)	
Satellite Licensees and Their Affiliates	)	

REPLY COMMENTS OF TELESAT CANADA

1. Telesat Canada ("Telesat" or "the Company") is pleased to submit the following reply comments in the above captioned proceeding.

2. In this proceeding, among other things, the Commission is proposing to permit non-geostationary satellite orbit ("NGSO") fixed-satellite service ("FSS") operations in certain segments of the Ku-band, and requests comment on technical criteria to ensure that such NGSO FSS operations do not cause unacceptable interference to existing users or unduly constrain future growth of incumbent services. As presented in the Notice of Proposed Rulemaking ("NPRM"), this technical information consists largely of the spectrum sharing criteria and provisional apfd/epfd limits developed at the 1997 International Telecommunication Union ("ITU") World Radiocommunication Conference ("WRC-97").

3. In its March 2nd comments filed in this proceeding, Telesat noted its concerns that much of the technical information and analysis necessary to establish appropriate limits to protect

against harmful NGSO FSS interference is not yet available.[1] Because of this incomplete knowledge base, Telesat submitted that it would be premature for the Commission to make a final ruling in this proceeding. Indeed, this was the view advanced by many parties submitting comments on the Notice of Proposed Rulemaking ("NPRM").[2]

4. This view was succinctly summarized as follows in the comments submitted by the broadly-based Satellite Coalition:

> "While ... appropriate sharing criteria can be developed, and are being developed, the WRC-97 provisional epfd and apfd limits have been shown to be inadequate and, therefore, the Coalition urges the Commission not to adopt these limits as final rules. As discussed in greater detail below:
>
> - the WRC-97 provisional limits were based on an incomplete technical record;
> - technical studies conducted after WRC-97 demonstrate that the WRC-97 provisional limits are insufficient to protect GSO FSS links, particularly links without a significant rain margin;
> - technical studies conducted after WRC-97 demonstrate that the WRC-97 provisional limits are insufficient to protect GSO BSS links; and
> - the WRC-97 provisional limits are 'single entry' limits and, therefore, fail to account for interference from multiple NGSO FSS systems.
>
> Rather than adopt the WRC-97 provisional limits, therefore, the Commission should continue to work with interested parties to examine the technical issues involved in NGSO use of GSO spectrum and, based upon this examination, develop criteria that will protect the investment in, and reliance upon, Ku-band GSO FSS and BSS satellites by U.S. [and other] satellite operators and users."[3]

5. Telesat strongly concurs with this view and would again urge the Commission to postpone any consideration of these technical limits until after WRC-2000, by which time all the pertinent technical information on which to make a fully informed decision should be available.

6. In the remainder of these reply comments, Telesat will respond to certain arguments and positions advanced by SkyBridge LLC ("SkyBridge") in its comments.

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[1] See Comments of Telesat Canada (filed March 2, 1999), paragraph 6.

[2] See, in particular, the respective comments of Loral Space & Communications Ltd., PanAmSat Corporation, GE American Communications Inc., the Satellite Coalition, QUALCOMM Inc., SBC Communications Inc., and DIRECTV Inc.

[3] Comments of the Satellite Coalition (filed March 2, 1999), pages 2-3.

RESPONSE TO SKYBRIDGE

7. In sub-section II A.1 of SkyBridge's comments, SkyBridge proposes a modification to the footnote in the U.S. Table of Allocations which addresses the ITU Radio Regulation S5.502. The modification essentially proposes to remove the mandatory requirement for an FSS uplink to transmit with a minimum EIRP of 68 dBW and that the FSS transmission claim no protection from, and assume the risk of interference from radiolocation operations. Telesat agrees with this proposal and the wording suggested for the change to the footnote.

8. In sub-section III A.2 of SkyBridge's comments, the relationship between the aggregate limits of interference from all NGSO FSS contributors and how single-entry limits might be derived from those aggregate limits is discussed. This is followed in sub-section III A.3 by a discussion of the maximum number of co-frequency NGSO FSS systems that could operate. To assess the net effect of all NGSO FSS interference sources on a given GSO FSS system, only the aggregate interference is required. However, recognizing from the NGSO FSS system designer's point of view that single entry limits are needed, Telesat accepts that an agreed-upon method of converting from aggregate limits to single entry limits is required. In this regard, Telesat notes that the Joint Task Group 4-9-11 (the "JTG") established at WRC-97 to study the co-frequency sharing issue has defined three zones as follows: Zone A for longer term interference where addition of interfering power applies; Zone B for shorter term interference where addition of interfered with time intervals applies; and Zone C where the highest level short term interference occurs and a worst case NGSO FSS system is defined. Having a Zone C would lead to a single entry epfd, which would be characterized by a worst case epfd equal to that of the worst case NGSO network. Thus, in this case, all single entry limits would be characterized by only the worst case network, even though the affected GSO FSS network might still suffer degradations from multiple NGSO networks. Telesat would therefore propose the deletion of Zone C.

9. In addition, rather than trying, as SkyBridge suggests, to define a "$N_{effective}$" and an "$N_{physical}$" to translate aggregate to single-entry values, a per satellite efpd would be more logical. The Zone A and B concept for scaling between aggregate and per satellite epfd would be a function of "X", the number of NGSO satellites sharing the band. Thus, if a NGSO FSS network

had "Y" satellites, one could scale from an aggregate to a per-network epfd using the factor Y/X for both Zones A and B. Accordingly, Telesat would argue that efforts should be directed at trying to arrive at a value of X rather than a value for N as SkyBridge suggests.

10. In sub-section III A.5 of SkyBridge's comments, a proposal for more reference antennas in addition to the three proposed under the WRC-97 provisional limits is made. Specifically, SkyBridge proposes adding revised epfd limits for a 1.2 meter and a 3 meter antenna. Telesat has no objection to this proposal.

11. In sub-section III A.5.B of SkyBridge's comments, single entry epfd limits are proposed for 0.6, 1.2, 3.0, 5.0 and 10.0 meter antennas. Given that only a limited number of links were analyzed vis-à-vis the protection afforded to them by these limits, Telesat believes it is premature at this time to decide on what limits are appropriate to protect GSO FSS systems. At the time that SkyBridge submitted it comments on the NPRM, the deadline of March 15, 1999 for submitting GSO FSS link characteristics in response to ITU-R Circular Letter 116 had not yet passed. Telesat is of the view that given the limited amount of data analyzed and the fact that there is no existing international agreement on a value of the maximum number of co-frequency NGSO systems, it is not possible at this time to conclude on what single-entry epfd limits are appropriate.

12. SkyBridge also cites the results of simulations performed specifically for the SkyBridge system which show that, for a 60 cm antenna, the maximum epfd level would be 3 dB lower than the worst case epfd level reached over time in 90% of the coverage area, and 7 dB lower in 50% of the coverage area. SkyBridge suggests that, for particular links which may not appear protected under the ITU-R S.1323 criteria, the impact of the NGSO FSS interference from its system may be mitigated by the fact that regions of worst case interference are geographically distributed, such that the most sensitive GSO FSS receivers are located in areas of only a few tens of kilometers in diameter. Telesat disagrees that this suggestion has any merit. A GSO customer whose earth station suffers unacceptable interference by virtue of its location would be severely disadvantaged and would derive no benefit from a high probability that interference would be within acceptable levels in other geographical areas. The simple fact is that this customer's level of service would be unacceptable. Moreover, this argument would appear to

suggest that the SkyBridge system does not optimally re-use spectrum if the areas of worst case interference are so non-uniformly geographically dispersed. Whatever the single entry limits recommended by the JTG for eventual acceptance at WRC-2000, all NGSO FSS systems must comply with the limits. Therefore, the orbital characteristics and the traffic management scheme selected for the proposed SkyBridge system may make it more difficult for SkyBridge to meet the single entry limits.

13. SkyBridge briefly discusses the issue of short-term interference into large antennas but does not adequately address a major concern raised by GSO FSS operators, namely, the possibility of loss of synchronization due to short-term, high-level NGSO FSS interference. Depending upon the type of application carried on the GSO FSS link, loss of synchronization can lead to extended periods of outage or down time. Users of these earth terminals are generally aware that temporary outages can be caused by naturally occurring phenomena such as rain fades and solar transits, but would not be prepared to accept outages caused by competing technological systems. Telesat is an operator of extensive networks which include existing GSO FSS terminals, and it is Telesat's responsibility to ensure that those networks will be protected from unacceptable degradation to quality of service due to band sharing with future FSS systems. There were proposals at the January 1999 JTG meeting stating that in the absence of naturally occurring phenomena which may be responsible for short-term outages, interference from NGSO FSS systems must not cause a synchronization loss. To address these concerns, Telesat would propose that all receive terminals in the 11.45-12.2 GHz band having an antenna diameter of 7.5 meters or less and a minimum clear sky margin of 1.0 dB be protected from synchronization loss under clear sky conditions due to interference from the downlinks of NGSO FSS systems.

14. Telesat generally agrees with SkyBridge's proposals set out in sub-section III E.3 of its comments on Transfer Orbit and Emergency Operations procedures. Telesat concurs that a dialogue between operators is important to ensure both the successful deployment of GSO and NGSO satellites, as well as the regaining of control of a satellite in an emergency situation. However, further study is required concerning Operational Telemetry, Tracking and Control ("TT&C") procedures. Although telemetry links tend to be very robust, the peak interference level in combination with the duration of the interference event generated by the NGSO downlink must be further studied.

15. In sub-section III E.4 of its submission, SkyBridge briefly responds to the Commission's request for comment on how it would protect GSO operations from malfunctioning NGSO satellites. The response does not, however, address the actual in-orbit performance of NGSO satellites and the interference caused by a NGSO satellite which is not malfunctioning but is not achieving its intended level of performance. As Telesat indicated at paragraph 17 of its comments, a supplementary procedure, such as that being developed by ITU-R Working Party 4A (Ref. ITU-R WP4A doc. TEMP/92 (Rev. 1)),[4] should be used for validating the actual hardware performance of a NGSO FSS satellite while it is in orbit.

16. In Appendix A of SkyBridge's comments, SkyBridge applies the Procedure D developed by France within the JTG. For the cases of the 0.6, 1.2 and the 3.0 meter antennas, in each case, SkyBridge states that the carriers submitted by Canada are not useable, claiming that the link unavailability calculated with rain only at the performance point is 100%. SkyBridge contends that the links were "clearly optimized with an older and uncompleted version of the Procedure D software". This is incorrect. The link availability in each case was calculated using a link budget. In fact, there was an error in the way that the parameters were copied into the CR-92 database. The transcription error is readily corrected as follows: *current values in row 64 should be in row 62 instead, while current values in rows 62 and 63 should replace rows 63 and 64, respectively.*

17. Also in Appendix A, SkyBridge put the Canadian C/(N+I) objective calculated to 9 decimal points in parentheses as if to question how the number could be so exact. The reason why the objective was stated to 9 decimal points was simply that the C/(N+I) objective was calculated from the Eb/No threshold (known to a single decimal place) without rounding off the data before it was entered into the CR-92 spreadsheet. The values calculated were simply "cut-and-pasted" into the spreadsheet. It is evident to Telesat that when SkyBridge ignores or removes the Canada GSO FSS link characteristics from their analysis, it distorts the results by appearing to prove that the epfd limits were not harmful to most GSO FSS systems. At the January 1999 JTG meeting, however, it was shown that, for 5 out of 21 carriers submitted, even the WRC-97 provisional limits caused the ITU-R S.1323 criteria of 10% increase in

unavailability to be exceeded. At this JTG meeting, France expressed no objection to the GSO FSS link characteristics presented by Canada. Thus, the SkyBridge statement that "[t]his could be due to an error in the new CR-92 database that did not copy exactly the parameters given by Canada" suggests that they knew that this error existed, but chose to ignore it. The ITU Secretariat has reissued the Canadian GSO FSS link characteristics in a corrigendum to the CR116 database. The GSO FSS parameters for the Canadian links presented at the January JTG meeting are included in Annex 1 below.

CONCLUSION

18. As was noted at paragraph 2 of the NPRM, SkyBridge indicated in its petition that NGSO FSS systems should be permitted to operate in the Ku-band subject to two conditions:

1) the system will cause no noticeable degradation to the quality or availability of GSO satellite operations and terrestrial links; and

2) the system will impose no operational constraints on GSO satellite and terrestrial operators.

19. Telesat concurs with these two conditions. However, as Telesat and the vast majority of other parties have argued in this proceeding, the technical criteria proposed for NGSO FSS systems by SkyBridge based on WRC-97 provisional limits may not be adequate to protect GSO FSS satellite and other operations from harmful interference. Further technical study is required, and is currently underway by the relevant ITU study groups. Until this work is completed and the results reviewed at WRC-2000, Telesat respectfully submits that the Commission should postpone any decision on these technical issues. Without this information, there is a strong possibility that inappropriate limits may be established for NGSO FSS systems, resulting in harmful interference to current and future GSO FSS satellite and other operations.

[4] This document was inadvertently referred to as a JTG document in Telesat's March 2nd comments.

20. Telesat appreciates the opportunity to participate in this proceeding, and hopes that its submissions will be of assistance to the Commission in its deliberations.

All of which is respectfully submitted this 29th day of March 1999.

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Vice President, Corporate Development
Telesat Canada

ANNEX 1

GSO FSS PARAMETERS PRESENTED AT THE JANUARY 1999 JTG 4-9-11 MEETING

1-1-1 : Ku band transparent (Annex 2 format)							
Carrier Number	361	362	363	364	365	366	367
ADMINISTRATION	CAN	CAN	CAN	CAN	CAN	CAN	CAN
JTG4-9-11 Document Number							
GEOSTATIONARY NETWORK	Anik E2	Anik E2	Anik E2	Anik E2	Anik E2	Anik E2	Anik E2
PERFORMANCE OBJECTIVES	1	2	3	4	5	6	7
Threshold #1 (N/A for not applicable): C/(N+I) (dB)	3.85	3.85	6.61	6.61	6.61	6.61	6.61
% of the year C/(N+I) should be exceeded	99.50	99.50	99.70	99.70	99.70	99.70	99.70
Threshold #1 (N/A for not applicable): C/(N+I) (dB)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
% of the year C/(N+I) should be exceeded	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Threshold #1 (N/A for not applicable): C/(N+I) (dB)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
% of the year C/(N+I) should be exceeded	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WAVEFORM DESCRIPTION							
Access type (TDMA, CDMA, FDMA,...)	FDMA	FDMA	FDMA	FDMA	FDMA	FDMA	FDMA
Modulation type (e.g. FM, QPSK, BPSK)	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
Noise bandwidth per carrier (kHz)	24000	24000	24000	24000	24000	24000	24000
TRANSMIT EARTH STATION CHARACTERISTICS							
Altitude (km)	0	0	0	0	0	0	0
Latitude (+: North, -: South) from Equator (degrees)	43.65	43.65	43.65	43.65	43.65	43.65	43.65
Elevation angle (degrees)	32.42	32.42	32.42	32.42	32.42	32.42	32.42
Temperature at ground level (°C)	15	15	15	15	15	15	15
Relative humidity (%)	50	50	50	50	50	50	50
Rain model (ITU/Crane)	ITU	ITU	ITU	ITU	ITU	ITU	ITU
Rain zone (as per rain model)	K	K	K	K	K	K	K
Rain fall rate exceeded for 0.01% of an average year (mm/h) if available	42	42	42	42	42	42	42
On-axis Earth station transmit e.i.r.p. (dBW)	73.50	73.50	73.50	73.50	73.50	73.50	73.50
Antenna pointing loss towards the geostationary satellite (dB)	0	0	0	0	0	0	0
Inter modulation earth stations C/I (dB)	100	100	100	100	100	100	100
Power control range (>0, 0 dB if none) (dB)	6.01	6.01	6.01	6.01	6.01	6.01	6.01
Power control accuracy (applicable only if up link power control used) (dB)	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Polarisation isolation (C/I of wanted to unwanted polarisation) (dB)	100	100	100	100	100	100	100
RECEIVE EARTH STATION CHARACTERISTICS							
Altitude (km)	0	0	0	0	0	0	0
Latitude (+: North, -: South) from Equator (degrees)	49	43	49	41.5	49.5	47.7	44.6
Temperature at ground level (°C)	15	15	15	15	15	15	15
Relative humidity (%)	50	50	50	50	50	50	50
Elevation angle (degrees)	33.46	33.99	33.46	35.66	32.87	15.03	22.93
Rain zone (as per rain model)	E	K	E	K	E	F	K
Rain fall rate exceeded for 0.01% of an average year (mm/h) if available	22	42	22	42	22	28	42
Earth station receive noise temperature (K)	146.5	146.5	146.5	146.5	146.5	146.5	146.5
On-axis antenna gain (dBi)	35.59	35.59	39.11	39.11	41.49	41.49	41.49
Antenna diameter(m)	0.6	0.6	0.9	0.9	1.2	1.2	1.2
Antenna pointing loss (dB)	0	0	0	0	0	0	0
Polarisation isolation (C/I of wanted to unwanted polarisation) (dB)	100	100	100	100	100	100	100
SPACE STATION RECEIVE CHARACTERISTICS							
Transponder bandwidth (MHz)	54	54	54	54	54	54	54
Receive frequency (GHz)	14.25	14.25	14.25	14.25	14.25	14.25	14.25
Receive polarisation (H: horizontal, V: Vertical, C: Circular)	H	H	H	H	V	V	H
Automatic level control range (0 if none) (dB)	0	0	0	0	0	0	0
Peak receive antenna gain (dBi)	32.43	32.43	32.43	32.43	32.43	32.43	32.43
Receive satellite antenna gain in the direction of transmit earth station (dBi)	32.43	32.43	32.43	32.43	32.43	32.43	32.43
Satellite receive temperature (K)	650	650	650	650	650	650	650
Receive cross-polarisation isolation (C/I ratio, 100 if not applicable) (dB)	25.42	25.42	25.42	25.42	25.42	25.42	25.42
Receive frequency re-use isolation (C/I ratio, 100 if not applicable) (dB)	100	100	100	100	100	100	100
Transponder total input back-off (dB)	3	3	3	3	3	3	3
SPACE STATION TRANSMIT CHARACTERISTICS							
Transmit frequency (GHz)	11.95	11.95	11.95	11.95	11.95	11.95	11.95
Transmit polarisation (H: horizontal, V: Vertical, C: Circular)	V	V	V	V	H	H	V
Transponder total output back-off (dB)	1.61	1.61	1.61	1.61	1.61	1.61	1.61
Satellite e.i.r.p. in the direction of the receive earth station (dBW)	42.80	44.53	42.54	44.43	40.25	42.88	43.15
Transmit cross-polarisation isolation (C/I ratio, 100 if not applicable) (dB)	24.71	24.71	24.71	24.71	24.84	24.84	24.71
Transmit frequency re-use isolation (C/I ratio, 100 if not applicable) (dB)	100	100	100	100	100	100	100
Transparent/remodulating transponder	Transparent	Transparent	Transparent	Transparent	Transparent	Transparent	Transparent
Satellite adjacent transponder isolation (dB)	100	100	100	100	100	100	100
Transponder inter modulation C/I(dB)	100	100	100	100	100	100	100
INTERFERENCE FROM OTHER GSO NETWORKS AND TERRESTRIAL SERVICES							
Up link clear-sky C/I due to other geostationary networks (dB)	31.85	31.85	31.85	31.85	32.55	32.55	31.85

1-1-1 : Ku band transparent (Annex 2 format)							
Carrier Number	361	362	363	364	365	366	367
ADMINISTRATION	CAN	CAN	CAN	CAN	CAN	CAN	CAN
JTG4-9-11 Document Number							
GEOSTATIONARY NETWORK	Anik E2	Anik E2	Anik E2	Anik E2	Anik E2	Anik E2	Anik E2
Up link clear-sky C/I due to sharing with fixed service (dB) (100 dB if no sharing)	100	100	100	100	100	100	100
Down link clear-sky C/I due to other geostationary networks (dB)	19.47	16.39	25.70	25.85	30.59	35.16	32.30
Down link clear-sky C/I due to sharing with fixed services (dB) (100 dB if no sharing)	100	100	100	100	100	100	100

1-1-1 : Ku band transparent (Annex 2 format)							
Carrier Number	368	369	370	371	372	373	374
ADMINISTRATION	CAN	CAN	CAN	CAN	CAN	CAN	CAN
JTG4-9-11 Document Number							
GEOSTATIONARY NETWORK	Anik E2	Anik E2	Anik E2	Anik E2	Anik E2	Anik E1	Anik E1
PERFORMANCE OBJECTIVES	8	9	10	11	12	14	15
Threshold #1 (N/A for not applicable): C/(N+I) (dB)	7.61	7.61	7.61	7.61	7.61	3.01	3.01
% of the year C/(N+I) should be exceeded	99.97	99.97	99.97	99.97	99.97	99.95	99.95
Threshold #1 (N/A for not applicable): C/(N+I) (dB)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
% of the year C/(N+I) should be exceeded	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Threshold #1 (N/A for not applicable): C/(N+I) (dB)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
% of the year C/(N+I) should be exceeded	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WAVEFORM DESCRIPTION							
Access type (TDMA, CDMA, FDMA,...)	FDMA	FDMA	FDMA	FDMA	FDMA	FDMA	FDMA
Modulation type (e.g. FM, QPSK, BPSK)	QPSK	QPSK	QPSK	QPSK	QPSK	BPSK	BPSK
Noise bandwidth per carrier (kHz)	24000	24000	24000	24000	24000	1225	1225
TRANSMIT EARTH STATION CHARACTERISTICS							
Altitude (km)	0	0	0	0	0	0	0
Latitude (+: North, -: South) from Equator (degrees)	43.65	43.65	43.65	43.65	43.65	43.65	43.65
Elevation angle (degrees)	32.42	32.42	32.42	32.42	32.42	30.51	30.51
Temperature at ground level (°C)	15	15	15	15	15	15	15
Relative humidity (%)	50	50	50	50	50	50	50
Rain model (ITU/Crane)	ITU	ITU	ITU	ITU	ITU	ITU	ITU
Rain zone (as per rain model)	K	K	K	K	K	K	K
Rain fall rate exceeded for 0.01% of an average year (mm/h) if available	42	42	42	42	42	42	42
On-axis Earth station transmit e.i.r.p. (dBW)	73.50	73.50	73.50	73.50	73.50	53.14	53.14
Antenna pointing loss towards the geostationary satellite (dB)	0	0	0	0	0	0	0
Inter modulation earth stations C/I (dB)	100	100	100	100	100	100	100
Power control range (>0, 0 dB if none) (dB)	6.01	6.01	6.01	6.01	6.01	10.00	10.00
Power control accuracy (applicable only if up link power control used) (dB)	0.01	0.01	0.01	0.01	0.01	1.00	1.00
Polarisation isolation (C/I of wanted to unwanted polarisation) (dB)	100	100	100	100	100	100	100
RECEIVE EARTH STATION CHARACTERISTICS							
Altitude (km)	0	0	0	0	0	0	0
Latitude (+: North, -: South) from Equator (degrees)	63.8	62.6	45	47.7	43	51.5	42.2
Temperature at ground level (°C)	15	15	15	15	15	15	15
Relative humidity (%)	50	50	50	50	50	50	50
Elevation angle (degrees)	11.40	18.95	36.33	15.03	33.99	31.00	33.58
Rain zone (as per rain model)	A	C	E	F	K	E	K
Rain fall rate exceeded for 0.01% of an average year (mm/h) if available	8	15	22	28	42	22	42
Earth station receive noise temperature (K)	141.5	141.5	141.5	141.5	141.5	160	160
On-axis antenna gain (dBi)	51.07	49.25	49.25	49.25	49.25	39.06	39.06
Antenna diameter(m)	3.7	3.0	3.0	3.0	3.0	1.0	1.0
Antenna pointing loss (dB)	0	0	0	0	0	0	0
Polarisation isolation (C/I of wanted to unwanted polarisation) (dB)	100	100	100	100	100	100	100
SPACE STATION RECEIVE CHARACTERISTICS							
Transponder bandwidth (MHz)	54	54	54	54	54	54	54
Receive frequency (GHz)	14.25	14.25	14.25	14.25	14.25	14.25	14.25
Receive polarisation (H: horizontal, V: Vertical, C: Circular)	V	H	V	V	V	H	H
Automatic level control range (0 if none) (dB)	0	0	0	0	0	0	0
Peak receive antenna gain (dBi)	32.43	32.43	32.43	32.43	32.43	34.33	34.33
Receive satellite antenna gain in the direction of transmit earth station (dBi)	32.43	32.43	32.43	32.43	32.43	34.33	34.33
Satellite receive temperature (K)	650	650	650	650	650	650	650
Receive cross-polarisation isolation (C/I ratio, 100 if not applicable) (dB)	25.42	25.42	25.42	25.42	25.42	20.21	20.21
Receive frequency re-use isolation (C/I ratio, 100 if not applicable) (dB)	100	100	100	100	100	100	100
Transponder total input back-off (dB)	3	3	3	3	3	8	8
SPACE STATION TRANSMIT CHARACTERISTICS							
Transmit frequency (GHz)	11.95	11.95	11.95	11.95	11.95	11.95	11.95
Transmit polarisation (H: horizontal, V: Vertical, C: Circular)	H	V	H	H	H	V	V
Transponder total output back-off (dB)	1.61	1.61	1.61	1.61	1.61	3.84	3.84
Satellite e.i.r.p. in the direction of the receive earth station (dBW)	34.23	36.48	38.23	41.44	44.01	32.76	32.70
Transmit cross-polarisation isolation (C/I ratio, 100 if not applicable) (dB)	21.07	24.66	24.80	24.77	24.80	15.56	15.57
Transmit frequency re-use isolation (C/I ratio, 100 if not applicable) (dB)	100	100	100	100	100	100	100
Transparent/remodulating transponder	Transparent	Transparent	Transparent	Transparent	Transparent	Transparent	Transparent
Satellite adjacent transponder isolation (dB)	100	100	100	100	100	100	100
Transponder inter modulation C/I(dB)	100	100	100	100	100	100	100
INTERFERENCE FROM OTHER GSO NETWORKS AND TERRESTRIAL SERVICES							
Up link clear-sky C/I due to other geostationary networks (dB)	32.55	31.85	32.55	33.74	32.55	32.77	32.77

1-1-1 : Ku band transparent (Annex 2 format)							
Carrier Number	368	369	370	371	372	373	374
ADMINISTRATION	CAN	CAN	CAN	CAN	CAN	CAN	CAN
JTG4-9-11 Document Number							
GEOSTATIONARY NETWORK	Anik E2	Anik E2	Anik E2	Anik E2	Anik E2	Anik E1	Anik E1
Up link clear-sky C/I due to sharing with fixed service (dB) (100 dB if no sharing)	100	100	100	100	100	100	100
Down link clear-sky C/I due to other geostationary networks (dB)	59.13	48.66	37.34	43.08	37.78	23.06	23.14
Down link clear-sky C/I due to sharing with fixed services (dB) (100 dB if no sharing)	100	100	100	100	100	100	100

1-1-1 : Ku band transparent (Annex 2 format)							
Carrier Number	375	376	377	378	379	380	381
ADMINISTRATION	CAN	CAN	CAN	CAN	CAN	CAN	CAN
JTG4-9-11 Document Number							
GEOSTATIONARY NETWORK	Anik E1	Anik E1	Anik E1	Anik E1	Anik E1	Anik E1	Anik C1
PERFORMANCE OBJECTIVES	16	17	18	19	20	21	22
Threshold #1 (N/A for not applicable): C/(N+I) (dB)	3.01	3.01	3.01	3.01	3.10	3.10	7.52
% of the year C/(N+I) should be exceeded	99.95	99.95	99.95	99.95	99.80	99.80	99.50
Threshold #1 (N/A for not applicable): C/(N+I) (dB)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
% of the year C/(N+I) should be exceeded	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Threshold #1 (N/A for not applicable): C/(N+I) (dB)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
% of the year C/(N+I) should be exceeded	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WAVEFORM DESCRIPTION							
Access type (TDMA, CDMA, FDMA,...)	FDMA	FDMA	FDMA	FDMA	FDMA	FDMA	FDMA
Modulation type (e.g. FM, QPSK, BPSK)	BPSK	BPSK	BPSK	BPSK	BPSK	BPSK	8PSK
Noise bandwidth per carrier (kHz)	1225	1225	1225	1225	300	300	23975
TRANSMIT EARTH STATION CHARACTERISTICS							
Altitude (km)	0	0	0	0	0	0	0
Latitude (+: North, -: South) from Equator (degrees)	43.65	43.65	43.65	43.65	51.50	42.20	-23.00
Elevation angle (degrees)	30.51	30.51	30.51	30.51	31.01	33.58	16.83
Temperature at ground level (°C)	15	15	15	15	15	15	5
Relative humidity (%)	50	50	50	50	50	50	50
Rain model (ITU/Crane)	ITU	ITU	ITU	ITU	ITU	ITU	ITU
Rain zone (as per rain model)	K	K	K	K	E	K	N
Rain fall rate exceeded for 0.01% of an average year (mm/h) if available	42	42	42	42	22	42	95
On-axis Earth station transmit e.i.r.p. (dBW)	53.14	53.14	53.14	53.14	38.36	42.17	77.72
Antenna pointing loss towards the geostationary satellite (dB)	0	0	0	0	0	0	0
Inter modulation earth stations C/I (dB)	100	100	100	100	100	100	100
Power control range (>0, 0 dB if none) (dB)	10.00	10.00	10.00	10.00	0.00	0.00	0.00
Power control accuracy (applicable only if up link power control used) (dB)	1.00	1.00	1.00	1.00	0.00	0.00	0.00
Polarisation isolation (C/I of wanted to unwanted polarisation) (dB)	100	100	100	100	100	100	100
RECEIVE EARTH STATION CHARACTERISTICS							
Altitude (km)	0	0	0	0	0	0	0
Latitude (+: North, -: South) from Equator (degrees)	50.4	41.5	48.9	44.6	43.7	43.7	-22
Temperature at ground level (°C)	15	15	15	15	15	15	
Relative humidity (%)	50	50	50	50	50	50	
Elevation angle (degrees)	31.93	33.39	12.74	20.56	30.49	30.48	20.38
Rain zone (as per rain model)	E	K	F	K	K	K	N
Rain fall rate exceeded for 0.01% of an average year (mm/h) if available	22	42	28	42	42	42	95
Earth station receive noise temperature (K)	160	160	160	160	238	238	140
On-axis antenna gain (dBi)	40.83	40.83	44.54	44.54	54.02	54.02	57.49
Antenna diameter(m)	1.2	1.2	1.8	1.8	5.6	5.6	7.6
Antenna pointing loss (dB)	0	0	0	0	0	0	0
Polarisation isolation (C/I of wanted to unwanted polarisation) (dB)	100	100	100	100	100	100	100
SPACE STATION RECEIVE CHARACTERISTICS							
Transponder bandwidth (MHz)	54	54	54	54	54	54	54
Receive frequency (GHz)	14.25	14.25	14.25	14.25	14.25	14.25	14.25
Receive polarisation (H: horizontal, V: Vertical, C: Circular)	H	H	H	H	H	H	H
Automatic level control range (0 if none) (dB)	0	0	0	0	0	0	0
Peak receive antenna gain (dBi)	34.33	34.33	34.33	34.33	33.63	31.63	28.97
Receive satellite antenna gain in the direction of transmit earth station (dBi)	34.33	34.33	34.33	34.33	33.63	31.63	28.97
Satellite receive temperature (K)	650	650	650	650	650	650	1250
Receive cross-polarisation isolation (C/I ratio, 100 if not applicable) (dB)	20.21	20.21	20.21	20.21	10.84	12.72	21.54
Receive frequency re-use isolation (C/I ratio, 100 if not applicable) (dB)	100	100	100	100	100	100	100
Transponder total input back-off (dB)	8	8	8	8	8	8	3
SPACE STATION TRANSMIT CHARACTERISTICS							
Transmit frequency (GHz)	11.95	11.95	11.95	11.95	11.95	11.95	11.95
Transmit polarisation (H: horizontal, V: Vertical, C: Circular)	V	V	V	V	V	V	V
Transponder total output back-off (dB)	3.84	3.84	3.84	3.84	3.84	3.84	1.61
Satellite e.i.r.p. in the direction of the receive earth station (dBW)	30.85	30.82	27.60	27.33	20.21	21.95	37.38
Transmit cross-polarisation isolation (C/I ratio, 100 if not applicable) (dB)	15.57	15.57	15.57	15.57	8.29	10.02	18.47
Transmit frequency re-use isolation (C/I ratio, 100 if not applicable) (dB)	100	100	100	100	100	100	100
Transparent/remodulating transponder	Transparent	Transparent	Transparent	Transparent	Transparent	Transparent	Transparent
Satellite adjacent transponder isolation (dB)	100	100	100	100	100	100	100
Transponder inter modulation C/I(dB)	100	100	100	100	100	100	100
INTERFERENCE FROM OTHER GSO NETWORKS AND TERRESTRIAL SERVICES							
Up link clear-sky C/I due to other geostationary networks (dB)	32.77	32.77	32.77	32.77	29.43	29.43	19.55

1-1-1 : Ku band transparent (Annex 2 format)							
Carrier Number	375	376	377	378	379	380	381
ADMINISTRATION	CAN	CAN	CAN	CAN	CAN	CAN	CAN
JTG4-9-11 Document Number							
GEOSTATIONARY NETWORK	Anik E1	Anik E1	Anik E1	Anik E1	Anik E1	Anik E1	Anik C1
Up link clear-sky C/I due to sharing with fixed service (dB) (100 dB if no sharing)	100	100	100	100	100	100	100
Down link clear-sky C/I due to other geostationary networks (dB)	24.99	25.03	28.36	28.59	31.29	33.03	71.57
Down link clear-sky C/I due to sharing with fixed services (dB) (100 dB if no sharing)	100	100	100	100	100	100	100